

## **Argumentation markers: Their emergence in the speech of physics teacher educators**

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### **Abstract**

In this article we approach the problem of identification and recognition of argumentation by teacher educators of a physics undergraduate course of a large university in the southeast of Brazil. Our proposed markers criteria, such as “opposing” of ideas and “reciprocal justifications” were partially validated by the investigated teacher educators in conducted interview processes. Most of them mixed aspects of argumentation with explanation and others offered alternative visions of argumentation in science teaching. These results are problematic since changes in basic education passes through the formation and education of new teachers and in-service teachers in teachers’ science programs. Implications of the study are raised as well the need to clarify more to the community of teacher educators the nature of argumentation and how it differs from explanations.

**KEY WORDS:** Argumentation, Physics Teacher Education, Alternative conceptions on argumentation, Explanations, Markers Criteria

### **INTRODUCTION**

This article is aimed both to the general public of researchers and teachers in general, especially university teachers, concerned with the definitions and nature of argumentation. Teachers can widen or restrict teaching and learning opportunities for students via the discourse patterns they establish and manage in their classrooms (Kelly, 2013). Inserted in the “discursive turn” milestone in modern psychology (Billig, 1996; Kuhn, 1992), argumentation within science classes has been the object of several research projects over the past twenty years, and the results found point increasingly to the importance of this particular form of discourse to science teaching (Jiménez-Aleixandre & Erduran, 2008).

However, a common factor in many Brazilian science classrooms is the complete lack of incentive to argumentation by the part of teachers (Vieira & Nascimento, 2013). Researches over the past twenty years show that discussion, via argumentation, in science teaching, is essential to make students understand science – the very nature of science – as well as

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appreciate and exercise the scientific argumentation (Jiménez-Aleixandre & Erduran, 2008; Kelly, 2013; Osborne, 2014).

Argumentation in classrooms can be beneficial to students as it: 1) develops the ability to understand concepts; 2) builds statements supported by evidence so as to give opinions and criticize other students' concepts, as well their own opinions; 3) allows reflection on a number of topics; 4) allows teacher and peer evaluation, since the presentation of arguments can be publicly acknowledged; 5) allows a greater development of autonomy and decision making abilities on a number of subjects, including socio-scientific issues (Vieira & Nascimento, 2013). In short, the practicing of argumentation in the classroom offers favorable conditions for the development of the dimensions of construction of persuasive procedures and attitudes in the students skills (Santos, Mortimer & Scott, 2001; Reis, 2013).

Results observed in this, as well as in other researches, are reflected in official educational documents, both in Brazil and abroad. In the US, both the American Association for Advancement of Science (AAAS, 1993) and the National Research Council (NRC, 1996) have pointed out the importance of students in understanding how scientific knowledge is attained and how argumentation can contribute to the construction of this knowledge base. National Research Council [NRC] (2012, explains that “science is not just a body of knowledge that reflects current understanding of the world; it is also a set of practices used to establish, extend, and refine that knowledge. Both elements—knowledge and practice—are essential” (p. 26).

Nationally, in Brazil, the PCN+ (Abbreviation meaning “National Curriculum Parameters for High School Education”, is in loose translation. The definition dates from 2002) states that the introduction of argumentation in science teaching is essential, since it contributes to the process of building scientific knowledge, as well as the ability to argument and offer opportunities for judgment of various statements based on available evidence. This ability is considered a prerequisite for an active and fair exercise of citizenship.

The PCN+ (Brasil, 2002, p.12) states that:

Informing and keeping informed, communicating, expressing one's self, presenting logical argument, accepting or rejecting arguments, manifesting preference, pointing out contradictions, adequately using terminology, codes or means for communication are general competences that should be integral resources of all fields of study. That, as such, should be developed when learning any and all of them.

One can clearly see, then, that argumentation is a recommendation for science teaching. Therefore, one could ask why teacher educators still resist when it comes to introducing argumentation in their classroom activities. Several possible causes may be listed, among

which is the “reproduction” ‘problem (Bourdieu & Passeron, 1975; Bourdieu, 2001), particularly in science teacher undergraduate courses. This means the issue could be linked directly to the practices and constructs being used in such undergraduate teaching certificate courses for science teachers.

According to previous results our research conducted inside such undergraduate science teaching courses (Vieira & Nascimento, 2008; Vieira & Nascimento, 2013), pre-service teachers undergoing such courses and their respective teacher educators show alternative preconceptions and lack of knowledge of what argumentation actually is and how to introduce it into the classroom. This point is important because the role of the teacher is imperative in fostering a classroom culture that successfully promotes argumentation (McNeill, 2009). Faced with this problem, we acknowledge the importance of science teachers recognizing and being able to understand clearly the differences between argumentation and other “discursive orientations” as such (e.g. explanation, narration, description, injunction and dialogue (see Vieira & Nascimento, 2013; Vieira & Kelly, 2014; Vieira & Nascimento, 2015a).

Both argumentation and explanation are built on reasoning (justifications), which can lead to confusion on the part of researchers and science teachers when considering the differences between those discursive orientations in their teaching practices in the classroom. Therefore, having teachers master these two types of discursive orientations can be considered even more crucial – if they cannot differentiate them, their students are certain to be puzzled when it comes to doing the same.

With that problem in mind, we will present in this paper various constructs that physics teacher educators have put forth on what argumentation is for them and then compare those constructs with the markers criteria for argumentation previously proposed by the same Vieira & Nascimento (2009) and (2013) – all based on converging fields of references (Billig, 1996; Adam, 2008; Bronckart, 1996).

To make such constructs explicit, interviews were conducted with previously selected physics teacher educators from both the Physics Institute and the Faculty of Education of a large public university in Southeast Brazil. All interviewed teacher educators have taught – or still teach – certificate courses for undergraduate physics students of the department of the same institution. The interview questions were developed aiming to raise the main teaches' motives, goals, strategies and difficulties of introducing argumentation in their classes. There were asked 8 questions to the each teacher. The analyzed question was the third one. We decided to analyze only this question because it is directly related to our research aims in this article. In this sense, the main purpose of this study is:

Raise the conceptions of a group of teacher educators and compare their visions with the criteria we developed to identify and characterize argumentation;

For this, we were guided by the following research questions:

- 1) How argumentation can be differentiated from other types of discursive orientations, including explanation? Which criteria can help teachers recognize and work with argumentation?
- 2) Which conceptions a group of physics teacher educators' held about argumentation when interviewed?
- 3) Which are the convergences and divergences among the teachers' views and the developed criteria?

The analysis of the responses was conducted based on the criteria proposed by (Vieira & Nascimento, 2009), and is based on theoretical references consolidated and converging from the previous mentioned field studies. Thus, based on those references, we will now establish what argumentation is from this convergence perspective – in the next topic.

### **WHAT IS ARGUMENTATION?**

Personal opinion, according to Breton (1999), is essential to understand argumentation. To this author, opinion is, at the same time, the set of beliefs, values and world representations held by a particular individual. Opinion is under constant change. It can be understood as a possible point of view – so, when two diverging opinions meet, the individuals interacting can produce arguments to defend their particular points of view, with the aim of convincing each other of their own particular point of view. It can be said that the argument is used to justify a specific opinion, with the goal of convincing a specific target audience.

Billig (1996) defines the argumentative context as “opposition and reasoning”. Vieira & Nascimento (2013), clarify the importance of differentiating argumentation from other such “discursive orientations” – particularly from explanation, also characterized by reasoning. According to Billig, a sentence may have a completely different meaning depending on the context in which it's uttered – so one must take into account what is being criticized and against which particular reasoning the counter-argument shall be presented.

Billig shares the thoughts of Protagoras, the sophist: it is possible to present an argument that favors both sides of a debate. In an argumentation, the notion of truth is directly linked to context and, therefore, is relative. Thus, if an opinion is criticized with a counter-argument, new arguments can be linked and added to the original one so as to criticize the counter-argument presented – and thus forth.

Once again, it can be seen that an argument that is valid under certain social circumstances might not prove valid once the setting is changed. Billig presents examples of how arguments can change form in different contexts: forensic arguing, where opinions and counter-opinions are very well defined; deliberative argumentation, referring directly to the

political speech in which the speaker is trying to persuade or dissuade their target audience; and epideictic argumentation, where the speaker formally reveres an individual, such as in a funeral, context in which argumentation is implicit since the speaker tends to work around to avoid explicit the weakness of the dead person.

Billig (1996), through Aristotle's work, refers to the relative tone of the argument to distinguish between mathematical logic and arguing. In the presentation of an argument, the notion on enthymeme is of central concern and consists of a statement accompanied by a justification, and this justification may be criticized. After criticism, a new enthymeme will be required to support the initial argument and this new enthymeme, on itself, might be subject to criticism. And this continues to be what characterizes the argumentation. One can reach the conclusion that arguments must be treated under a more enthymemic perspective, rather than under a syllogistic one, since syllogisms have a non-controversial characteristic because the premises themselves actually carry the conclusions within them.

Billig (1996) suggests that arguing is possible under the existence of "the other". Meaning another person with whom one might be able to argue. The author emphasizes that the continuous search for the last word in an argument is a constantly present characteristic, and also observes that listeners are not always willing to accept arguments easily. Actually, on most occasions, listeners in an argumentation scenario prove to be inflexible and avid defenders of their own words. Therefore, persuasion is not always the end result, however good the arguments favoring a particular stand might be. As Billig explains, the ultimate search for the last word should not be seen as the sole motive behind the argumentative process, but rather as the factor responsible for its maintenance

From these perspectives on argumentation, one question can be raised: how to introduce the argumentation process into science classes? For the answer, let's introduce and discuss the concept of "discursive orientation".

## **ARGUMENTATION AND DISCURSIVE ORIENTATIONS**

Discursive genres are stable discursive situations that arise from various social contexts (Rojo, 2005). Vieira & Nascimento (2013) propose to investigate how the different forms of textual language organization (called "sequences" by Adam, 2008) are articulated to compose the genres employed in a science class. Textual sequences are forms of language organization that, according to Adam (2008) are forms of textual language structure that surpass and entail the phrasal level of analysis.

Adam defined each sequence in terms of a particular prototype in a way that a segment of text may be closer or further from a particular prototype. As an example, the Toulmin Argument Pattern (Toulmin, 1958) can be considered a prototype to analyze the structure of arguments. Here, six types of relevant sequences are being considered when

investigating the textual patterns developed in a science class: argumentative, explicative, narrative, descriptive, dialogue and injunctive. It can be highlighted that the explicative discursive orientation is very often mistaken for the argumentative discursive orientation (Vieira & Nascimento, 2013).

From these sequences and considering the real discourse situations, in which one's can merge discourse patterns with others, with no clear boundaries but with a dominant one that determines the scope of the patterns been developed, we recognize, from these sequence types, six kinds of discursive orientations (e.g. argumentative, narrative, explicative, descriptive, injunctive, dialogue). That is, six types of dominant discursive patterns that shapes one's discursive contributions and in turn are shaped by these same contributions.

As we mentioned, students and teachers do not know the differences between explanation and argumentation. It becomes necessary, then, to create clear criteria to allow the understanding of their differences and the implications for teaching and learning.

Bronckart (1999) considers the explanatory thinking to have originated, mainly, from the consideration of an indubitable phenomenon by the interacting parties. One basic difference between argumentation and explanation is the controversial or non-controversial character of the statements. If presented as an argument, a statement becomes controversial while, in explanation, a statement is considered a shared instance between the parties – meaning it is presented as something that cannot be disputed, but that might require development or widening of concepts due to some gaps in knowledge.

According to Charaudeau & Maingueneau (2004), a certain symmetry between parties is required for the establishment of an argumentation, in a way that the acknowledgment of the various status levels among them concerning the subject at hand can be reciprocal. This means one tends to engage in an argumentation only when it can be verified that the opposing party possesses at least almost the same level of knowledge of the subject at hand. Thus, both opinions can be viewed as probable instead of one establishing itself as indubitable due to the asymmetry between the parties.

Explanation, on the other hand, implies a greater asymmetry between the parties: one of the involved will be viewed as a spokesperson for a particular subject. The spokesperson will then have authority, which would come from an privilege of social status or from the higher knowledge and comprehension of a particular topic. Usually, in a classroom, this party is the teacher. He or she holds a highly asymmetric position in regard to the students. This distinction can be diminished, however, depending on the way the teacher presents the topic and the concepts being presented.

The teacher's posture when managing discussions by means of eliciting answers and providing opportunities for the students to speak up are ways of stimulating the establishment of an argumentative situation.

According to research conducted by Vieira (2007), in teacher methods courses, argumentation can take place when students were familiar with the concepts, as well as when the subject at hand was of public knowledge – and most people feel comfortable giving opinions on such subjects. This means the asymmetry described here is also directly linked to the familiarity and knowledge a student has on certain topics. Thus, it becomes essential to set up strategies and procedures that aim at reducing the asymmetry between the parties in a way to allow for a greater use of argumentation in the classroom. Additionally, a set of strategies and procedures must be drawn to guarantee that the asymmetry will be later regained when the teacher took this decision.

Thus, the importance of the differentiation and understanding of argumentation as a discursive resource is essential. For that aim, teachers should also understand and differentiate the discursive patterns, so as to promote the same understanding for their students (Abd-el-Khalick, 2003; Dawson & Venville, 2010; Knight & McVeill, 2011; Osborne et. al., 2013; Simon, Erduran & Osborne, 2006; Zembal-Saul et. al., 2002). In our case, we differentiate these patterns from the notion of discursive orientation.

In this paper the analysis of the responses given by teachers in interviews on what argumentation is will be presented and compared with the markers criteria for argumentation proposed by Vieira & Nascimento (2009, 2013). Finally, the implications and perspectives for research and teacher education will be presented as well.

## **METHODOLOGY PROCEDURES**

The first step in the methodological procedures was conducting semi-structured interviews with teacher educators working in a undergraduate certificate physics course. The teachers were chosen based on the following criteria: 1) the personal experience of the second author of this paper, since he studied in such a course and experienced the teaching and pedagogical practices first hand because the author was student of the major part of the teachers of this group; 2) dialogues with several colleagues taking the same course, where the same author had the opportunity to inquire about the opinions of those teachers; 3) in the willingness of the teacher educators when asked to take part of this study.

Inquiries were made in these interviews regarding the “presenting an argument” theme, and the first question was defined as:

*“What is argumentation in your understanding?”*

In this article we will focus only in the responses to this first question. The second stage was the construction of the “narrations frames” (component of the method for discourse analysis proposed by Vieira, Kelly & Nascimento, 2012; Vieira & Kelly, 2014) for each interviewee, where the answers to that particular question were narrated



by the analyst. The narrations frames are presented in Table 1, where the analysis of the responses is shown.

**Table 1: “What is argumentation in your understanding?”**

Teacher	Narrative of the responses	Summary
Roberto	States “I don’t really understand much” and that teaching shouldn’t be simply presenting a concept or, to put it rather rudely, “forcing on” a concept. The idea would rather be to present and discuss, to build an idea based on the presentation of an argument.	To this teacher, argumentation is presenting and discussing a particular concept in the classroom.
Maria	States that argumentation (as far as common sense goes) happens when a dialogue can be established to explain and justify her thoughts on something; and that this is putting forth an argument (“When I do this I’m presenting an argument”). In this process she states she presents reasons and justifications to explain a particular phenomenon and to justify her position by presenting an argument. The teacher says she’ll listen to other arguments and, should a consensus present itself, she might even be inclined to yield on some points – and other participants could do so as well. She states the notion of dialogue is essential to the concept of putting forth an argument. She presents an example of the “falling body”, where she states: “The body falls down because it goes down, period. So I’ll explain why it’s falling downward and why it can’t fall upward”. She mentions she’ll use her arguing power to explain something. She also says she can present justifications and reasoning even beyond the concept of a conclusive perspective – as is the case with abortion or the death penalty. In those cases, her arguments will focus on which principles are involved in defining her position in those issues – and according to her, this is what presenting an argument really is.	This teacher considers argumentation to be the process of explaining a particular point of view and justifying it through a dialogue.



Matias	<p>The presenting of arguments is a process where two people are engaged in a dialogue. And for this dialogue to exist, and with it an opposing of ideas, it's necessary for the person to be willing to listen to the other. This will only happen if both voices are empowered, if both people respect each other as the producer of a speech to which it is worthwhile to listen. He exemplifies by stating that a teacher should keep a dialogue-based posture and always try to listen to the student – because this is the only way, he says, to establish a dialogue that's fundamental to the development of the argumentation process. It is also necessary, according to him, for the dialogue's focus to create an environment for the opposing of ideas, for which one subject can position himself, while the other stays against the main idea. This will allow a debate to develop. He concludes saying these are the conditions necessary for the establishment of argumentation processes in the classroom.</p>	<p>To this teacher, argumentation is establishing a dialogue where ideas can be opposed.</p>
Daniela	<p>This teacher states that argumentation in the classroom means the teacher is offering the students an opportunity to express their own ideas, build their own thought processes and ideas. And that happens when there's dialogue in the classroom and the student is allowed time to speak.</p>	<p>To this teacher argumentation is giving their students the opportunity to speak and build their thought process, and that it should be done through dialogue.</p>
Felipe	<p>States that argumentation is presenting arguments. In general, this happens when one tries to defend a particular point of view or line of thought, and when one tries convincing a counterpart that theirs is the correct point of view. And for that, according to him, one must present some facts. The argument is the fact or line of thought and the argumentation process is the idea of organizing and connecting these arguments in a clear way, so that you can convince any counterpart of your point of view.</p>	<p>To this teacher argumentation is defending a point of view based on facts or lines of thought (arguments) with the intent of convincing someone.</p>
Rafael	<p>This teacher says that, to him, argumentation is a critical form of debate, where people put forth their points of view without forcing their opinion onto others, but for a better understanding of the subject at hand. He believes argumentation is essential.</p>	<p>To this teacher, argumentation is a critical debate of a subject, where people present points of view for a better understanding of something.</p>
Anderson	<p>This teacher states that argumentation is the building of thought processes based on evidence.</p>	<p>To this teacher, argumentation is building ideas based on data or facts that can show how the thinking process is correct.</p>

The third step was the construction of a synthetic version of the “narrations frame” for each interviewee, which basically consists of synthesizing each teacher’s response (see third column in table 01). The fourth and final step was the analysis of the absence or presence (both explicit and implicit) of the aforementioned markers in the teacher’s speech.

## ANALYSIS AND RESULTS

Based on the theoretical grounds presented in this paper we can now evaluate the initial concepts the interviewed teacher educators have of argumentation.

Prior to the analysis stage, the teachers in question will be briefly described, their lecturing subjects specified, as well as their working standards and roles. All teachers have been given assumed names to safeguard their privacy.

### Roberto

Roberto teaches two subjects: Physics III (covering hydro and thermodynamics, waves and optics) and Experimental Physics IV (covering an assortment of modern physics experiments). Both subjects are taught in the undergraduate Physics course, as well as in some of the engineering courses taught by the same University. In the Physics III subject his practices entail the explanation of concepts by following the syllabus predefined by the coordination. In Experimental Physics IV he assists students in assembling the experiments following the steps predefined in another syllabus. Afterwards, he indicates which measurements should be taken and described in a report that will be handed in for evaluation. In the first, he behaves as a “concept explainer” by following the contents and scripts of the textbook. In the second, his role is more that of an instructor, teaching students how to assemble pre-made experiments and how to use them for measurement, as well as how to treat those measurements so conclusions can be drawn on the phenomena involved in the apparatus.

This teacher states in his interview that argumentation is presenting and discussing a particular concept in the classroom – meaning the introduction of a theme and its following discussion.

The word “discussion” is overloaded with meanings that may or may not be in line with the definitions of what argumentation is given by Vieira & Nascimento (2013). To discuss, in the sense of opposing, is a perspective that meets the dialectic proposed by authors. Thus, this teacher implicitly presented a concept on argumentation that is in line with one of the definitions given by Authors, “opposition”. However, the teacher failed in making explicit what he understands as “presenting and discussing a particular concept in the classroom”. Would it be, maybe, to

“introduce a topic and talk about it”? In this case, where would justification stand among the argumentation developed in the classroom?

This analysis indicates the presence of the “opposition” marker, but the “reciprocal justification” marker was absent. The teacher himself acknowledged the fact that he does not “really understand much” on the subject of argumentation.

### Maria

Maria teaches a single subject: Syllabus Production and Strategies for the Teaching of Physics II, available only for the undergraduate Teaching Physics course. In her classes, she asks students to read texts pertaining to trends and methods of physics teaching so that afterwards they can be discussed by the class. By the use of scripts, she proposes the production of syllabuses that will aid in the teaching of physics, such as experimental kits.

The teacher performs two roles: 1) debate mediator in the classroom, making sure students do not deviate from the subject at hand, commenting on certain statements and proposing the students be questioned on their opinions, urging them to support their points of view; 2) the role of instructor and helper in the assembly of experiments and the confection of lectures and classes involving said experiments.

Thus, she seeks to teach her students how to create syllabuses and their classroom applications. In several instances, experience is exchanged by all present in the classroom. She measures this exchange and it becomes richer by studying the texts and assembling the experiments.

This teacher states, in her interview, that argumentation is explaining a specific point of view and supporting it with reasoning by means of a dialogue. This means, in essence, making your opinion known and stating your reasons to hold it.

In Vieira & Nascimento (2013) it is stated that teachers and students are not clear on the difference between explanation and argumentation. One can note that the definition given by the teacher differs from that proposed by Vieira & Nascimento (2013): she thinks argumentation is explaining an opinion and supporting it with justifications without, however, expecting a counter position from the audience. In the presentation of an argument the statements are more controversial while, in explanation, they are non-controversial – meaning they are presented as indubitable. There are not, in her statement, any indicators that there should be reciprocal justifications nor that there should be opposition of ideas between the parties in argumentative situations.

This analysis shows that both the “opposing ideas” and the “reciprocal justifications” markers were absent.

## Matias

Matias teaches two subjects in the undergraduate Teacher Physics course: teaching methods course II and teaching methods course IV. Both are focused on understanding and building the pedagogical knowledge of concepts (Shulman, 1986), or practical knowledge of future teachers via the combination of both subjects with the mandatory internship. He also teaches one subject at the Post-Graduation Course of the Teacher Education Department. In all his subjects, he usually requires students to read certain literature, normally pertaining to the trends and methods of physics teaching, so that they can be openly discussed in the following classes.

To that end, this teacher acts as a debate mediator between students, comments on opinions put forth and does not allow students to get off the topic. During the debate, besides commenting the ideas of the excerpt's author, students present personal opinions on the text and topic and support those opinions with reasoning. This is when the argumentation takes place: opinions can be agreed or disagreed with via the presentation of counter-arguments.

The subjects taught by this teacher allow for reflection and argumentation of topics and he takes on the role of director, steering the debate with notes and incitements that generate more and more arguments. Said debates have, in this case, the power to incite reflection, build and widen awareness on educational issues in general and of the science teaching in particular.

This teacher states, in his interview, that argumentation is establishing a dialogue where ideas can be opposed, a conversation where parties present different opinions.

One can see that this definition meets the Vieira & Nascimento (2013) propositions head on: argumentation is an opposing of ideas where there should be reciprocal justifications to support opinions given. One can also note that this second premise is not in the teacher's definition, since he does not mention reasoning nor reciprocal justification. Furthermore, the teacher repeatedly uses the word 'dialogue' to define argumentation. Dialogue and argumentation are, however, different discursive orientations as can be seen on Vieira, Kelly & Nascimento, (2012), Vieira & Nascimento(2013).

Thus, the teacher merges two discursive orientations to define one –argumentation – which he sees as a dialogue. This is a troublesome perspective, since the two discursive orientations do not overlap as noted in Vieira & Nascimento (2013). Another way to understand the teacher's stance is to perceive how dialogue may open the adequate space for arguing; Under this stance, dialogue could precede argumentation, making it's arisal a possibility.

This analysis shows the "opposing ideas" marker was present, while the "reciprocal justifications" one was not. Additionally, the teacher mistakenly overlaps the definitions of dialogue and argumentation.

### Felipe

Felipe teaches only one subject: Statistical Physics, taught in the Physics BSc. In his classes he basically explains the subject's concepts and, according to his own evaluation, attempts to teach the students a logical thinking process towards the resolution of exercises. To that end he takes on the role of lecturer, predominantly, which in turn tends to impose a logic he himself considers to be the most adequate and correct in the solution of problems. He does not encourage his students to take an active role in his classes, and his reasoning behind this posture is that the students themselves make the undertaking – discussing and actively participating in class – very hard.

This teacher states, in his interview, that argumentation is defending a point of view based on fact or line of thinking (argument), aiming to convince another – meaning trying to convince another person that your personal opinion is the correct one, supporting that argument with facts or lines of reasoning.

The teacher's construct meets only the first premise proposed by Vieira & Nascimento (2013): when he states that argumentation is defending a point of view aiming to convince another, one can infer that diverging opinions enticed a party to state their argument – and therefore, this implicitly touches the “opposing of ideas” marker. However, when the teacher states that, in order to defend a point of view one should use fact or argument, can it be inferred that he means the use of justifications? If one does go as far as assuming that, one must still ask oneself if that reasoning is reciprocal – which is not clear on this teacher's concept. We can conclude that, explicitly, this second marker is missing.

The analysis shows the “opposing of ideas” marker is present, while the “reciprocal justifications” one is not.

### Rafael

Rafael teaches only one subject: Statistical Physics taught in the Post-Graduation in Physics course. In his classes, he explains the concepts of the subject basing his explanation on the textbook and without enticing any sort of debate or classroom interaction. Thus, he takes on the role of lecturer – meaning he behaves as a traditional teacher from the perspective of physics research. He states that alternative lessons are difficult to prepare because of the unyielding nature of the subject and of the reduced number of students in his classes.

This teacher states, in his interview, that argumentation is critically debating a subject in a situation where people present a particular point of view so that they can better understand the subject at hand – meaning they discuss and present opinions on a particular subject matter.

From this statement one can infer that the expression “to critically debate” entails both the opposing of ideas and the reciprocal justifications to support those ideas, since a debate necessarily means there are diverging opinions and both agreement and disagreement about those

ideas. The teacher, however, does not explicitly specify what he means by the phrase “critically debating a subject”. In fact, the teacher may be considered exceedingly succinct in presenting his definition.

This analysis shows the implicit presence of both the “opposing of ideas” and “reciprocal justifications” markers.

### Daniela

Daniela teaches a single subject: Syllabus Production and Strategies for the Teaching of Physics I at the undergraduate Teaching Physics course. In her lessons, she proposes the construction of low cost syllabus materials by following scripts that will aid the physics teaching – such as experimental kits. She also requires students to read texts that, overall, approach current physics teaching methods so that the class can discuss them on future opportunities.

In this case the teacher takes on two different roles: 1) the instructor and helper in the construction of experimental kits and the planning of lessons that include those kits; 2) the debate mediator role, making sure students don not deviate from the subject matter, offering comments on specific opinions and steering the discussion toward questioning the opinions of the text authors and other students, making sure they support every idea put forth.

In this way, the teacher seeks to develop in her students the ability to think critically and to reflect on the reading and discussing of topics, as well as other abilities connected with building syllabuses and their use. On many occasions, with the aim of showing more effective methods, she promotes the exchange of experience among those present in the classroom so that new ideas can be put in practice. All of these stances are always supported by the texts and experiments being studied.

Daniela states, in her interview, that argumentation is giving the student the opportunity to speak up and build their thought process through dialogue – meaning a teacher should provide the adequate environment for sharing opinions and discussion, so that all may build knowledge through experience.

She connects argumentation and dialogue (the same way Matias did), and says that only through those can knowledge be built. We acknowledge that giving the student the space and opportunity to speak up is an important didactic stance on the teacher’s part, especially when it comes to inciting an argument. However, this teacher does not associate, in her entire presentation, the concept of argumentation with the idea of contradiction. Thus, by merging dialogue and argumentation, she differs from the theoretical base point for this role – which clearly differentiates both discursive orientations. Therefore, both the “opposing of ideas” and the “reciprocal justifications” markers are absent from her construct, since she fails to make explicit that students should support their opinions and try to convince each other of their conclusions.

This analysis, in consequence, shows the absence of both markers.

## Anderson

Anderson teaches two subjects: Thermodynamics, taught in the undergraduate Physics courses; and Activities for Physics teaching, taught exclusively at the undergraduate Teaching Physics course. On the Thermodynamics subject, he mostly employs lectures on the concepts. On the Activities for Physics Teaching, he usually requires students to conduct the proposed exercises and activities in a previously given special notebook so that, in the next lesson, the replies may be discussed by the group.

In the first case (thermodynamics), he basically explains the concepts of the subject, proposing questions and selecting students' answers with the aim of attaining what is relevant for the sequence of the lecture, dispensing answers that can be considered incorrect. Thus, he performs mostly as a lecturer in this scenario. On the second stance (activities for teaching), he is the dispenser of the correct answers: students answer the questions in the notebook and support those answers with reasoning, and he corrects both the answers and the reasoning as required. Depending on the question posed and the number of students diverging, he asks the group to present arguments of their interpretations. During the following stage of the lesson students will debate their viewpoints on the questions and physics situations presented, always supporting those opinions with reasoning based on the laws and definitions of physics and trying to convince each other of the correct response. The teacher only intervenes when a law or definition is misused during the reasoning. The teacher then takes on the role of corrector of responses and reasoning.

This teacher states, in his interview, that argumentation is the construction of reasoning based on evidence – meaning the ability to build ideas based on data or facts that might strengthen or show the thinking process to be correct.

The definition presented by this teacher is not in line with the ones proposed by the Vieira & Nascimento (2009; 2013) – the ones based on opposing of ideas and reciprocal justifications, where there should be interaction of the parties, ideas should be put forth and supported with the intent to convince one's counterpart. In fact, the construction of lines of thought based on evidence can be conducted without the opposing of ideas and reciprocal justifications, since the support offered for a thought process does not necessarily entail counter-reasoning or an opposing thought.

This teacher affirms, in his interview, that argumentation is to construct reasoning based on evidences, which means constructing ideas based on data or facts that can strengthen or show that the reasoning is correct.

This analysis shows the absence of both the “opposing of ideas” and the “reciprocal justifications” markers.



## SYNTHESIS

Table 2, as follows, summarizes the analysis of the markers in each teacher's definitions.

**Table 2: Results of the marker criteria analysis**

Teacher	Explicit presence of the "opposing ideas" marker	Implicit presence of the "opposing ideas" marker	Explicit presence of the "reciprocal justification" marker	Implicit presence of the "reciprocal justification" marker
Roberto	No	Yes	No	No
Maria	No	No	No	No
Matias	Yes	No	No	No
Felipe	Yes	No	No	No
Rafael	No	Yes	No	Yes
Daniela	No	No	No	No
Anderson	No	No	No	No

## CONCLUSIONS

This study has potential to inform the field with results that add to previous knowledge, such as: 1) how complex is the problem of introducing argumentation in science education contexts, 2) on how the teachers differentiate argumentation from other types of discourse and, 3) providing means to establish contrasts among the established criteria and the teacher's responses. It is important that teachers recognize argumentation and differentiate it from explanation, for example. Such a competency will help them to produce discursive practices in their classroom more aligned with the recommendations of the official documents. We consider the need of work on this issue not even because it is a recurrent interpretation error, but also because, in speaking of teacher education, such a mistake can turn itself in a chain reaction.

The argumentation process established in the classroom has great potential to entails various subjects. In physics teaching it may be used as a teaching method aimed at the enrichment of discussions and the promotion of further development of abilities and capacities that are essential in the making of a citizen – such as sharing information, research, analysis, reflection and both individual and collective problem solving. Additionally, it promotes the development of what can be considered the citizen's most important ability: the consciousness process of decision making (Vieira & Nascimento, 2013).

From this perspective, the basic education teacher has a fundamental role, since it is in this stage that the students form the base of their character and develop traits that will influence them for life. The authors of this article defend, here, that the teacher should appreciate quality education. However, there are still a very large number of inconsistencies. This occurs for a number of reasons, including those linked to a lack of knowledge of the discursive orientations: their meanings, their differences (particularly the difference between argumentation and explanation), what a dialogue is and which didactic goals each of these discursive orientations best serves.

From the analysis presented, we offer our contribution, in this paper, to the problem of the concepts of argumentation held by teacher educators. Through this we were able to unveil one of the aspects of teacher education that contributes to teachers – that are, on their part, basic education teachers – having a closed stance toward promoting argumentation in their classrooms. If teacher educators themselves still promote lacking and alternative concepts of argumentation, teachers of basic education levels will hardly be able to implement this resource as a practical routine aspect of their lessons. This is a relevant problem inside the teacher educators' community and courses – especially those directed at science teaching – that should be dealt with more argumentation processes.

Furthermore, more closed courses, such as Statistical Physics, as described by the interviewed teachers, were understandable the courses with more difficulties to promote argumentation as, in the view of the interviewed teachers, such disciplines, due to their own characteristics, do not allow argumentation processes. We agree that in this case arguments and discussions are more difficult to implement, but even in this case this is not impossible. One can always raise a counter-part against what is lectured, and this can widen the comprehension of the topic that has been taught. The argumentation should not only be viewed as a way to gain correct conclusions, but, by the other side, in this case, reinforce these correct conclusions by means of counter arguments which may enrich the interactions by means of “firing” more complex thought processes in the classroom discourse and thus, in the students' cognition and understanding of the topic taught to the students.

We contend that this paper did not intend to bring forth the detailed – and definite – concepts of argumentation held by the teacher educators interviewed. The intention was to show how those concepts are lacking in terms of the contradiction aspect of argumentation. The reciprocal justification marker was also lacking in the interviewees' definitions. However, even facing those results it can be noted that teachers show understanding of other aspects of argumentation – such as building lines of thought based on evidence, interaction, willingness to hear and participate and attempting to convince one's counterparts. Those weren't, however, the main points of this paper.

In conclusion, argumentation in science education is still a troublesome situation, even though it is widely recognized by the research community and official documents as an urgent, paramount tool in XXI century education. Thus, it is necessary to advance argumentation research, with the goal of making it a solid aspect of school life. Other such papers we published have shown that a simulated jury activity is an important didactic resource in promoting quality argumentation in the classroom (Vieira & Kelly 2014; Vieira et. al., 2015b). Teaching via investigation, group and laboratory work, usage of information technologies and the introduction of socio-scientific issues in the classroom are all key components to establish argumentation in these spaces. From that premise, research takes a fundamental role side with teachers, aimed at stimulating the reasonable use of innovation in the classroom so as to promote discursive practices that are more consistent with the goals and objectives of current science education field.

## REFERENCES

- Abd-el-khalick, F. (2003). Socioscientific issues in pre-college science classrooms. In: Zeidler, Dana (Ed.). *The role of moral reasoning on socioscientific issues and discourse in science education*. London: Kluwer Academic Publishers.
- Adam, J. M. (2008). *A lingüística textual: introdução à análise textual dos discursos*. São Paulo, Cortez.
- American Association for the Advancement of Science (AAAS). (1993) *Benchmarks for science literacy: Project 2061*. New York: Oxford University Press.
- Billig, M. (1996). *Arguing and thinking: A rhetorical approach to social psychology*. Cambridge: Cambridge University Press.
- Bourdieu, P. & Passeron, J C. (1975). *A reprodução; elementos para uma teoria do sistema de ensino*. Rio de Janeiro: Francisco Alves.
- Bourdieu, P. (2001). *Meditações Pascalianas*. Rio de Janeiro: Bertrand Brasil.
- Brasil, Secretaria de Educação Média e Tecnológica. (2002). *PCN+ Ensino médio: Orientações educacionais complementares aos parâmetros curriculares nacionais. Ciências da natureza, matemática e suas tecnologias*. Brasília: MEC, SEMTEC.
- Breton, P. (1999). *A argumentação na comunicação*. 1ª Ed. Bauru SP: EDUSC.
- Bronckart, J. P. (1999). *Atividade de linguagem, textos e discursos: por um interacionismo sócio-discursivo*. São Paulo: EDUC.
- Charaudeau, P. & Maingueneau, D. (2004). *Dicionário de análise do discurso*. São Paulo: Contexto.
- Dawson, V. & Venville, G. (2010). *Teaching strategies for developing students' argumentation skills about socioscientific issues in high school genetics*. Research in Science Education, 40(2), 133– 148.

- Jiménez-Aleixandre, M. P. & Erduran, S. (2008). Argumentation in science education: An overview. In S. Erduran, M. Jiménez-Aleixandre (Eds.), *Argumentation in science education: Recent developments and future directions*. Dordrecht: Springer.
- Kelly, G. J. (2013). Discourse practices in science learning and teaching. In: Lederman, N.G., Abell, S. (ED), *Handbook of research on science education*. NY: Routledge Volume 2.
- Knight, A. M. & McNeill, K. L. (2011). The relationship between teachers' pedagogical content knowledge and beliefs of scientific argumentation on classroom practice. In: *Annual Meeting of the National Association for Research in Science Teaching*, Orlando.
- Kuhn, D. (1992). *Thinking as argument*. Harvard Educational Review, 62, p. 155-178.
- McNeill, K. L. (2009). Teachers' use of curriculum to support students in writing scientific arguments to explain phenomena. *Science Education*, 93, 2, 223 – 268.
- National Research Council NRC. (2012). *A framework for K-12 science education*. Washington, DC: National Academies Press.
- National Research Council (NRC). (1996). *National science education standards*. Washington, DC: National Academy Press.
- Osborne, J. (2014). Teaching scientific practices: Meeting the challenge of change. *Journal of Science Teacher Education* 25(2), 177–196.
- Osborne, J., Simon, S., Christodoulou, A., Howell-Richardson, C. & Richardson, K. (2013). Learning to argue: A study of four schools and their attempt to develop the use of argumentation as a common instructional practice and its impact on students. *Journal of Research in Science Teaching*, 50(3), 315–347.
- Reis, P. (2013). Da Discussão à Ação Sociopolítica sobre controvérsias Sociocientíficas: uma questão de cidadania. *Ensino de Ciências e Tecnologia em Revista*, 3(1).
- Rujo, R. (2005). Gêneros do Discurso e Gêneros Textuais: Questões Teóricas e Aplicadas. In: Meurer, J. L., Bonini, A.; Motta-Roth, D. (org). *Gêneros: Teorias, Métodos, Debates*. São Paulo: Parábola.
- Santos, W. L. P.; Mortimer, E. F. & Scott, P. H. (2001). A argumentação em discussões sócio-científicas: reflexões a partir de um estudo de caso. *Revista Brasileira de Pesquisa em Educação em Ciências*, v. 1, n. 1, p. 140-152.
- Shulman, L. (1986). Those who understand: Knowledge growth in teaching. *Educational Researcher*, 15(2), p. 04-14.
- Simon, S., Erduran, S. & Osborne, J. (2006). Learning to teach argumentation: Research and development in the science classroom. *International Journal of Science Education*, 28(2/3), 235–260.
- Toulmin S. (1958). *The uses of argument*. Cambridge, MA: Harvard University Press.
- Vieira, R. D. & Kelly, G. J. (2014). Multi-level discourse analysis in a physics teaching methods course from the psychological perspective

- of activity theory. *International Journal of Science Education*, v. 36 (16), 2.694-2.718.
- Vieira, R. D. & Nascimento, S. S. (2008). Avaliações de argumentação de licenciandos em Física sobre um episódio de estágio curricular: em que critérios eles se baseiam? In: *EPEF, XI* (2008), Curitiba. Atas, 01-12.
- Vieira, R. D. & Nascimento, S. S. (2009). Uma proposta de critérios marcadores para identificação de situações argumentativas em salas de aula de ciências. *Caderno Brasileiro de Ensino de Física*, Florianópolis, 26, 81-102.
- Vieira, R. D. & Nascimento, S. S. (2015a). Argumentação e orientações discursivas na educação em ciências. (2015a). *Ensaio: Pesquisa em Educação em Ciências*, Belo Horizonte, 17(3), 707-725.
- Vieira, R. D. (2007). Situações argumentativas na abordagem da natureza da ciência na formação inicial de professores de física. 173f. Dissertação (Mestrado em Educação) – Faculdade de Educação, UFMG, Belo Horizonte.
- Vieira, R. D., Bernardo, J. R. R., Evagorou, M. & Melo, V. F. (2015b). Argumentation in Science Teacher Education: The simulated jury as a resource for teaching and learning. *International Journal of Science Education*, 37(7), 1113-1139.
- Vieira, R. D. & Kelly, G. J., Nascimento, S. S. (2012). An activity theory-based analytic framework for the study of discourse in science classrooms. *Ensaio: Pesquisa em Educação em Ciências*, Belo Horizonte, 14(2), 13-46.
- Vieira, R. D. & Nascimento, S.S. (2013). *Argumentação no ensino de ciências: tendências, práticas e metodologia de análise*. Curitiba: Appris.
- Zemal-Saul, C., Munford, D., Crawford, B., Friedrichsen, P. & Land, S. (2002). Scaffolding preservice science teachers' evidence-based arguments during an investigation of natural selection. *Research in Science Education*, 32(4), 437-463.